U.S. Reports

facilitates automatic chip handling;
▶ Providing a deeper cut than diamond scribers and to give a higher yield at the breaking operation;
▶ According to Dicken, a savings in silicon real estate.

Dicken notes that 7 mils is the usual line width for diamond scribers—including a 3-mil scribe line and a 4-mil safety factor. The laser scribe line is more typically 0.5 to 1 mil wide, and Dicken says just 1 mil saved on the die perimeter can offer major cost savings. He thinks it might be possible to pack devices close enough together to get a 5% increase in the number of dice per wafer.

As for silicon splattering, Dicken says: "The power and wavelength of the laser can control this." Dicken says he's seen several examples of dice taken from wafers that had been either scribed all the way through or only partially through and then broken apart, and reports that the dice looked "very good." He favors partially cutting through the wafer, however, because he feels it would be difficult to cut through a 10-mil thickness without problems as the semiconductor industry turns more and more to 2-inch wafers at that thickness. But if the cost of laser silicon scribing equipment got down to $10,000, "it would probably take over the scribing market," Dicken observes.

What goes up. A. Robert Ruiz, laser sales administrator in the Hughes Electron Dynamics division, says the optics modification required to make the resistor trimmer—called Model 5561H—a silicon wafer scriber would involve changes to direct the laser beam up from the bottom of the equipment so that the cut is made on the wafer bottom, eliminating splattering onto the active device surface. This would be followed by a conventional breaking operation.

The machine, however, probably wouldn't incorporate the binocular microscope it now does as a resistor trimmer, nor would it necessarily include a Hughes-supplied table. Elimination of this hardware would lower the price.

The yag laser in the 5661H has an average power of 0.75 watt and 2,000 watts of peak power. The 1.06-micron wavelength allows a laser beam spot size of about 0.5-mil diameter, but the width of the scribe line depends on the quality of the optics used to focus the beam.

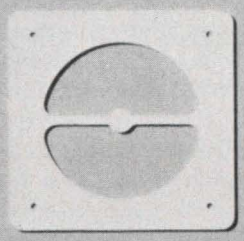
Ruiz says Hughes has been doing laser dicing for two semiconductor manufacturers in the San Francisco area for about six months, in addition to the MOS manufacturer for whom Hughes built the custom machine that has yet to be bought. For one of these firms, the laser cut too deep at first, and splattering was a big problem with a spot diameter of almost 1 mil. Hughes tried again with a 0.5-mil spot size and got better results, then tried scribing from the back of the wafer, but the cut wasn't deep enough. The effort continues, and Hughes is trying to improve the yag laser design to reduce its cost. The laser alone cost $19,000 just a year ago, but the entire resistor trimmer will go on the market priced $2,000 less than that, so Hughes is inching down toward the figure at which ICE's Dicken estimates laser wafer scribing could present a serious challenge to diamond scribing.

Dicken is quick to point out, though, that such diamond-scribing equipment suppliers as the Tempress Research Co. are working on improved techniques, and don't seem to be too concerned about being challenged soon by lasers. Another vote in favor of lasers, though, comes from Benson Austin, president of Affiliated Manufacturers Inc., a manufacturer of semiconductor chip handlers and feeders. He says, "Laser scribing holds tremendous promise in a field that has needed correction for several years."

Commercial electronics

Little push

A mirror smooth sheet of plastic less than one-eighth inch thick with printed numbers on it is likely to be a mockup of a keyboard, right? Not this time; the three-month-old Flex-Key Corp. of Waltham, Mass.,



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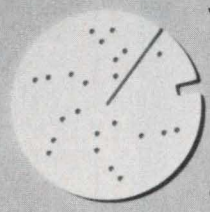

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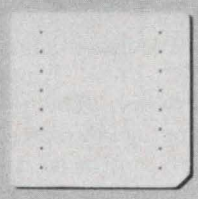

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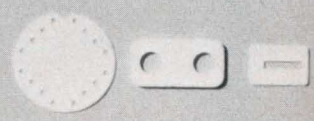

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has developed a keyboard without apparent failure mechanisms, with good potential for very low cost mass production, and a very thin structure—from an eighth to a quarter of an inch thick. And it looks like a fat plastic card—compared to present designs, most of which use (or have evolved from) reed switches and are 2 to 3 inches thick, the Flex-Key design is vanishingly small.

Designed by the company's president, William B. Sudduth, the keyboard is an integrated design. Instead of building up an array of individual key switches to form the size of board desired, Sudduth's keyboards can be turned out as a unit in a vacuum forming press.

Thus it takes no more work to make one single key than to make a typewriter-sized keyboard, and with a labor-cost advantage like this, Sudduth says he eventually will sell encoding keyboards to computer input-output terminal makers for as little as $30 to $50 in quantity.

The keyboard is a sealed laminate. On the bottom is an epoxy printed-circuit board, and laid down upon it at the position of each key are interdigital conductive paths: shorting across any two of these "fingers" turns on the switch. The p-c board is masked, using silk-screen techniques so that it supports a flexible conductive plastic layer. Atop the conductive plastic is an elastic sheet used to give a springier feel to the keyboard. And covering all is a smooth white sheet of Mylar with the "keys" printed on it. This is the eighth-inch-thick version—thinner than many p-c boards alone.

The quarter-inch version eliminates the smooth Mylar top layer and the springy plastic underneath it and combines their roles in a rubbery layer with raised and embossed keys. So in this version, there are only three major layers.

From here. Right now, Flex-Key is making arrangements with a large keyboard maker to sell 10- to 12-key units into the numerical input field—adding machines and such. The company is concentrating on this market first, rather than the seductive computer terminal

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field, because it is here that it hopes to find quantity production and cash flow.

But an independent phone maker, impressed with the keyboard's seeming ability to "live forever," has ordered samples for button phones. Also, at least two computer terminal makers are looking at the keyboard, and a calculator maker has ordered samples.

But terminals still are attractive. The more buttons on a keyboard, the greater is Flex-Key's labor-cost advantage over standard keyboard formats. Thus, Sudduth speculates that his firm could produce a keyboard for a maximum of 50 cents a key in competition with reed devices that would cost 60 to 70 cents per key for the least reliable versions. Encoding would be an extra-cost feature in both cases. But Sudduth is thinking about encoding keyboards selling for $30 to $50.

If the user needed the version with raised buttons, the price would be about one-fourth higher than the flat-topped Mylar version of the keyboard.

Dexterity. But Flex-Key's basic design may have enough flexibility to be able to work in the custom computer terminal market. It's possible that one basic printed circuit could be made to satisfy all user needs and only the p-c board's masking and the Mylar-printed top layer would have to be changed.

Sudduth feels that when the right opportunity arises, he could get into production quickly because of the keyboard's simple construction. He estimates only two weeks total elapsed time to begin quantity production of flat-topped keyboards, and perhaps a month to gear up and produce units with keys you can feel.

Contracts

Small—and vanishing

Military contracting policies that allegedly discriminate against the small businessman in favor of the few large defense contractors are causing a growing concern on Capitol Hill. "Small business is gradually being squeezed out of defense contracting," says Richard